A PRIMER ON THE WELFARE EFFECTS OF REGULATORY REFORMS IN NETWORK INDUSTRIES

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A primer on the welfare effects of regulatory reforms in network industries*

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Abstract

Starting from an industry where production is provided by a public monopolist, we look at the effects on the consumers' surplus of a sequence of reforms in network industry. Using a simple comparative statics framework, we find indifference conditions in consumers' surplus between respectively public monopoly, unregulated private monopoly, regulated private monopoly, vertically disintegrated monopoly, duopoly and liberalized market. The results are determined by the relative size of the x-inefficiencies of the public monopolist, allocative inefficiencies of private monopoly, the cost of unbundling and costs related to establishing a competitive market.
JEL: D40, L51, L32, L33
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1 Introduction

Aim of this paper is to show in a very intuitive way the welfare effects of switching from a public vertically integrated monopoly to other different market's forms. In particular, we analyze five market's reforms: (i) the unregulated privatization of the public monopolist, (ii) the regulated (*via* price-cap) privatization of the public monopolist, (iii) the unbundling of the integrated industry, (iv) the establishing of a duopoly by opening the market to an incumbent and finally (v) full market opening.

We characterize the model by considering a linear market's demand, we compute the consumers' surplus in the five different scenarios and we compare the results with the starting point. The differences will arise both from the different suppliers' objective functions and from the different marginal costs borne by the different suppliers.

The benevolent public monopolist will maximize the consumers' surplus and will bear a marginal cost higher than the efficient one (because of x-inefficiencies). The unregulated private monopolist will be technically efficient and it will maximize profits. The same will happens for the regulated private monopolist, but it will be forced to charge a lower price than the unregulated one. In the duopoly set-up the incumbent will set quantity and price to maximise profits, the

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entrant will do the same on the residual market demand. Under market opening the firms will choose quantity in order to have price equal to marginal cost. Both the institution of a duopoly and market opening will generate the loss of economies of integration: again the marginal cost will be higher than the efficient one.
We will conclude that it cannot be established the welfare dominance of a specific reform pattern in comparison with different arrangements including public monopoly.

2 The Model

The starting point of our exercise is a market where there is a public monopolist. We refer to a network industry such as, for instance, electricity or fixed telephone (see for example Newbery (1999)). We assume that the public monopolist faces a linear market demand curve:

$$p^{Pu} = a - bq$$

and that the marginal costs (c^{Pu}) are constant and higher than the marginal costs of a competitive market (c), because of some inefficiency ($\alpha > 0$):

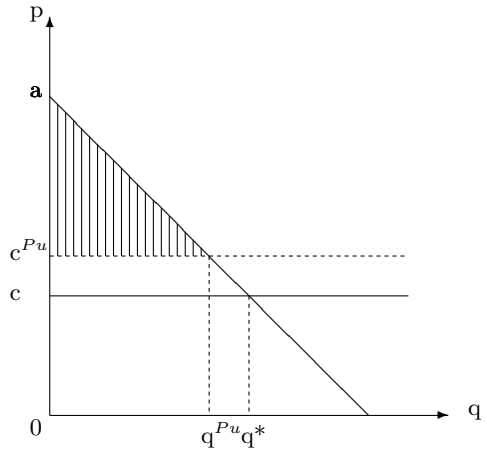
$$c^{Pu} = c(1 + \alpha)$$

Moreover, we assume that the public monopolist's problem is to maximize consumers' surplus. Hence, the production takes place where market demand equals public monopolist's marginal costs:

$$q^{Pu} = \frac{a - c}{b}$$

and the consumer consumers' surplus is just the area below the market demand function and above the marginal costs (see Figure 1).

Figure 1: Public Monopoly



Let us now assume that the public monopolist is privatized (see for an extensive analysis Vickers and Yarrow (1988)). We assume that a desirable result from privatization is realized: since the private monopolist has incentive to minimize costs, its marginal cost is the market

efficient marginal cost: c. The monopolist's problem becomes now to maximize profits. Therefore, at the optimal choice of output we have marginal revenues equals marginal costs. Given the linear demand described above, the marginal revenue function is:

$$MR(p^{UPr}) = a - 2bq$$

The optimal output is:

$$q^{UPr} = \frac{a-c}{2b}$$

The unregulated private monopolist charges the maximum price it can get at this level of output (we assume price discrimination is not feasible):

$$p^{UPr} = \frac{a+c}{2}$$

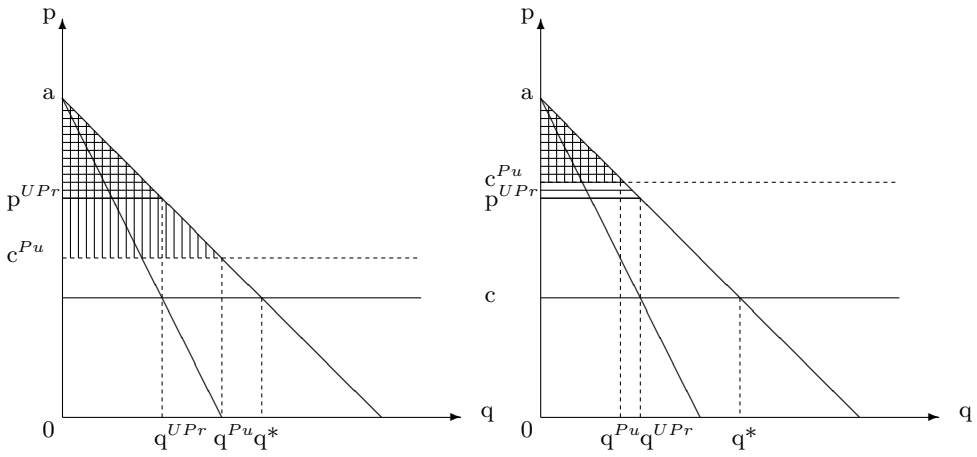
The consumers' surplus is now the area between the demand function and the price charged by the firm, which is greater than the marginal cost (see Figure 2).

Do we get any improvement, in terms of consumers' surplus, moving from a public monopolist to an unregulated private one? The answer depends on how inefficient is the public monopolist, in particular it depends on the relation:

$$\alpha \lessgtr \frac{a-c}{2c}$$

If α is small enough, it is better an inefficient public monopolist than a private one.

Figure 2: Public vs. Unregulated Private Monopoly



For instance, the economy represented in Figure 2 on the left will loose surplus after the privatization of the public industry. On the other hand, the right-hand side graph depicts a case where privatization leads to a better market equilibrium, from the consumers' point of view. Hence, in order to rank the two different markets based on consumers' surplus evaluation, we need to be able to compare the x-inefficiency of the public monopolist with the allocative inefficiency of the private one.

In order to limit the deadweight loss associated with the monopolist's equilibrium, we assume that the government appoints a regulator who fixes a maximum price the monopolist can

charge. Seeking for simplicity, we model this price-cap as the maximum tolerated mark-up (β) above the competitive market's marginal cost:

$$\hat{p} = c(1+\beta)$$

The regulated private monopolist keeps production at its optimal level:

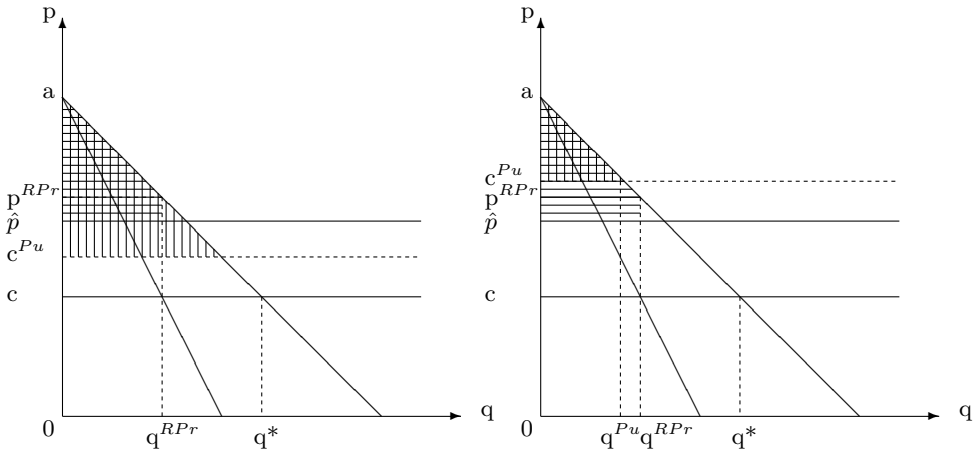
$$q^{RPr} = \frac{a-c}{2b}$$

but now it can charge just $\hat{p}$.
Hence, consumers' surplus increases for sure in comparison with the unregulated private monopoly. But, again, nothing can be stated, *a priori*, on the welfare dominance between public and regulated private monopoly because it depends on the relation:

$$\beta \lessgtr \frac{2a(c+4c\alpha) - a^2 - c^2(1+8\alpha+4\alpha^2)}{4(a-c)c}$$

Therefore, the reform has a positive impact on consumers' welfare only if β (the maximum tolerated mark-up) is smaller than some function of the public monopolist's inefficiency α, as depicted in the following Figure 3, right graph. On the other hand (Figure 3, left), the regulatory reform will reduce consumers' surplus.

Figure 3: Regulated Private vs. Public Monopoly

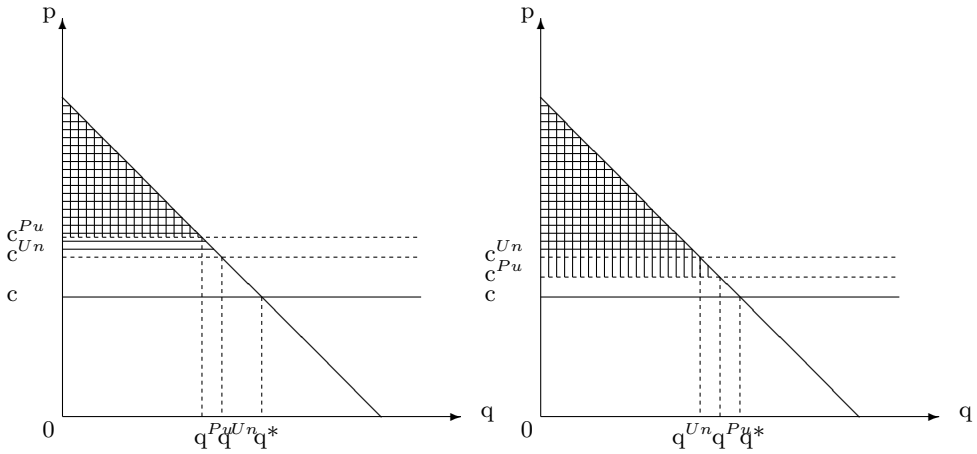


Let us suppose now that a new reform is implemented: the regulator imposes the unbundling of the network operator (see for example Pollitt (2007a), Willner (2008)). For instance, it forces the separation of supply from generation. Note that consumers' preferences are not influenced: the market's demand function is the same as before.

But we can reasonably assume that dividing the production process into different steps increases costs since we are loosing economies of integration: for example, we are duplicating administration costs and principal-manager incentives' problems. Hence, costs faced by the firm are higher than the competitive marginal cost:

$$c^{Un} = c(1+\gamma)$$

Figure 4: Unbundling vs. Public Monopoly



Once again, it can be both the case that the reform increases consumers' surplus, as depicted in Figure 4 on the left, when the public monopolist's technical inefficiency is high enough:

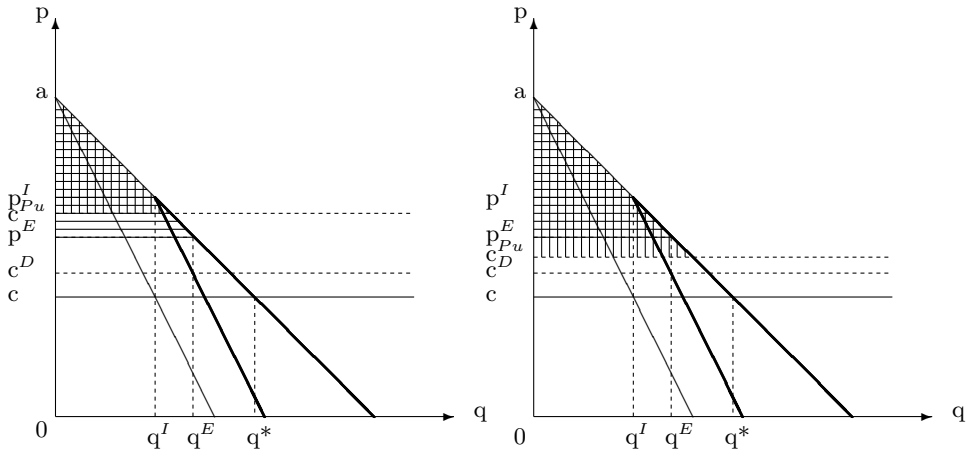
$$\alpha > \gamma$$

or that it makes consumers' worse-off (as in Figure 4 on the right), when unbundling-related costs are high enough:

$$\alpha < \gamma$$

In the next step of the reform the regulator offers a new license establishing a duopoly in the consumers' retail market. To simplify, we follow here Chamberlin's small groups' model, Chamberlin (1933)). The new entrant faces the residual market demand (the thick segment in the picture) left by the incumbent and higher costs (for example, it bears costs for an advertising campaign).

Figure 5: Duopoly vs. Public Monopoly



The competition arising from the duopoly entails a lower equilibrium price (the incumbent has to follow the price set by the entrant since the good is homogeneous) and higher production than the private monopoly's. On the other hand, using the same arguments as in the unbundled market, costs increase ($c^D = c(1+\delta)$). With respect to the starting point (integrated public monopolist), consumers' surplus can be both higher (Figure 5, left graph) or lower (Figure 5, right graph): the result depends on the relative size of public monopolist' inefficiency α and duopoly inefficiency δ:

$$\alpha \lessgtr \frac{a-c}{c} - \frac{1}{4}\sqrt{\frac{3a^2 - 6ac + 3c^2 + 8ac\delta - 8c^2\delta + 4c^2\delta^2}{c^2}}$$

In the last step of the reform, consumers' retail market is opened to competition. Following the Cournot model with many firms (Cournot (1897) and Varian (1987), pp. 452-453), let us suppose there are n firms and let $q = q_1 + q_2 + \cdots + q_n$ be the total industry output. We can write the firm's profits' maximizing condition as:

$$\begin{aligned} MR &= MC \\ p(Y) + \frac{\Delta p}{\Delta Y} y_i &= c_n \end{aligned}$$

We can rewrite the second condition as:

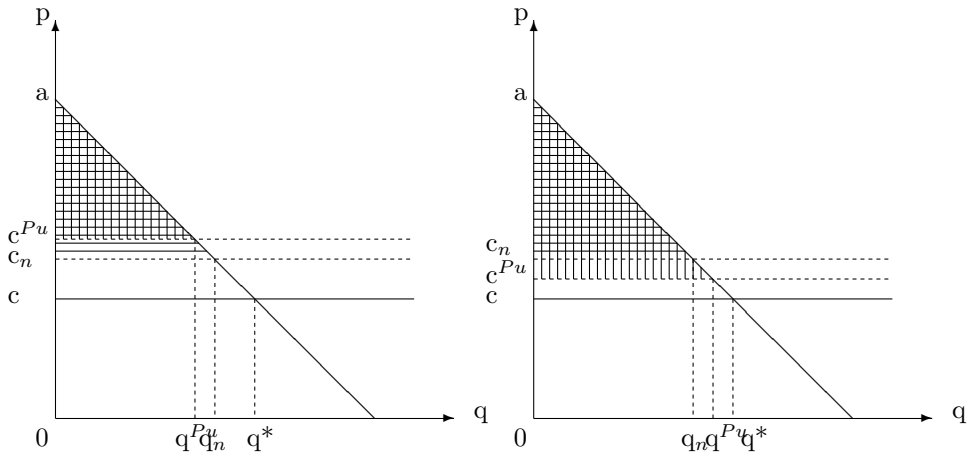
$$p(Y)\left[1 + \frac{\Delta p}{\Delta Y}\frac{Y}{p(Y)}\frac{y_i}{Y}\right] = c_n$$

Recall that $\frac{\Delta Y}{\Delta p}\frac{p(Y)}{Y}$ is the definition of elasticity of the aggregate demand curve $|\epsilon(Y)|$, and let $s_i = \frac{y_i}{Y}$ be the $i-th$ firm's share of total market output. The above condition becomes:

$$p(Y)\left[1-\frac{s_i}{|\epsilon(Y)|}\right] = c_n$$
$$p(Y)\left[1-\frac{1}{|\epsilon(Y)|/s_i}\right] = c_n$$

We can think of $|\epsilon(Y)|/s_i$ as the elasticity of the demand curve facing the single firm: the smaller the market share of the firm, the more elastic the demand curve it faces. Note that if $s_i = 1$, the firm is a monopolist, and the condition boils down to the unregulated monopolist's. If, instead, the firm market share tends to zero, the condition reduces to that of pure competitor: price equals marginal costs.

Figure 6: Market Entry vs. Public Monopoly



To keep things simple, in our model firms are all similar to each others, and have the same level of marginal costs. Nevertheless, note that we index marginal cost by the number of firms operating in the industry $c_n = c(1+\epsilon)$, in a way that: $\epsilon_1 < \epsilon_2 < \cdots < \epsilon_n$. Marginal costs are an increasing function of the number of firms in the market, and this is because of the loss of economy of scale and integration.

In the same way as in the previous steps of the reform process, the result of the market opening in terms of consumers' surplus depends on the relative size of the public monopolist and private firms' inefficiencies:

$$\alpha \lessgtr \epsilon_n$$

If the x-inefficiencies of the public firm (α) are bigger then the technical and allocative inefficiencies of the different types of private firms (ϵ_n), the public monopoly is still a better solution for the network industry (Figure 6, left). On the other hand, when $\epsilon_n < \alpha$, market opening is desirable reform (Figure 6, right)

3 Conclusion

We have shown that would make the consumer indifferent, in welfare terms, indifferent between public and private provision of services in network industries under different market structures. The analysis has been carried out in a merely theoretical way. For the discussion of the policy implication of different reform patterns see for example Willner and Parker (2007) or Pollitt (2007b).

The relative size of consumers' surplus depends, even in the basic model we have discussed, on a wide list of information. We need to know whether and to what extent the public monopoly is inefficient, whether the regulator is strict in setting the price-cap for a private monopolist and how much inefficiency is created by unbundling and market opening. Therefore it seems far from being obvious that a standard package of reforms across countries and industries would be always and everywhere welfare improving.

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Appendix

Table 1: Market's Equilibria and Consumers' Surplus under different market assumptions

	Quantity	Price	Consumers' Surplus
Competitive market	$q^C = \frac{a-c}{b}$	$p^C = c$	$cs^C = \frac{(a-c)^2}{2b}$
Public monopoly	$q^{Pu} = \frac{a-c(1-\alpha)}{b}$	$p^{Pu} = c(1+\alpha)$	$cs^{Pu} = \frac{(a-c(1+\alpha))^2}{2b}$
Unregulated private monopoly	$q^{UPr} = \frac{a-c}{2b}$	$p^{UPr} = \frac{a+c}{2}$	$cs^{UPr} = \frac{(a-c)^2}{8b}$
Regulated private monopoly	$q^{RPr} = \frac{a-c}{2b}$	$p^{RPr} = c(1+\beta)$	$cs^{RPr} = \frac{(a-c)^2}{8b} + \frac{(a-c)}{2b}\left[\frac{(a+c)}{2} - c(1+\beta)\right]$
Unbundled market	$q^{Un} = \frac{a-c(1-\gamma)}{b}$	$p^{Un} = c(1+\gamma)$	$cs^{Un} = \frac{(a-c(1+\gamma))^2}{2b}$
Duopoly	$q^D = \frac{(a-c)}{4b} + \frac{a-c(1-\delta)}{2b}$	$p^D = \frac{a+c(1-\delta)}{2} - \frac{(a-c)}{4}$	$cs^D = \frac{(3a+c(2\delta-3))(a+c(2\delta-1))}{32b}$
Market Entry	$q^{ME} = \frac{a-c(1-\epsilon_n)}{b}$	$p^{ME} = c(1+\epsilon_n)$	$cs^{ME} = \frac{(a-c(1+\epsilon_n))^2}{2b}$